Quantum Coherence and Tunneling in Semiconductor Nanostructures

Woowon Kang, University of Chicago, DMR-0213745

Semiconductor physics have laid the foundation for the modern electronics industry. Future advances will likely involve devices with new functionalities based on the quantum mechanical properties of electrons. Here we present a time dependent measurement of two-dimensional sheet of electrons formed at the interface between two different semiconductors. A phase transition into a ground state termed a quantum Hall ferromagnet is demonstrated. The long characteristic time of ~2 days establishes a potential avenue for exploring quantum information processing.

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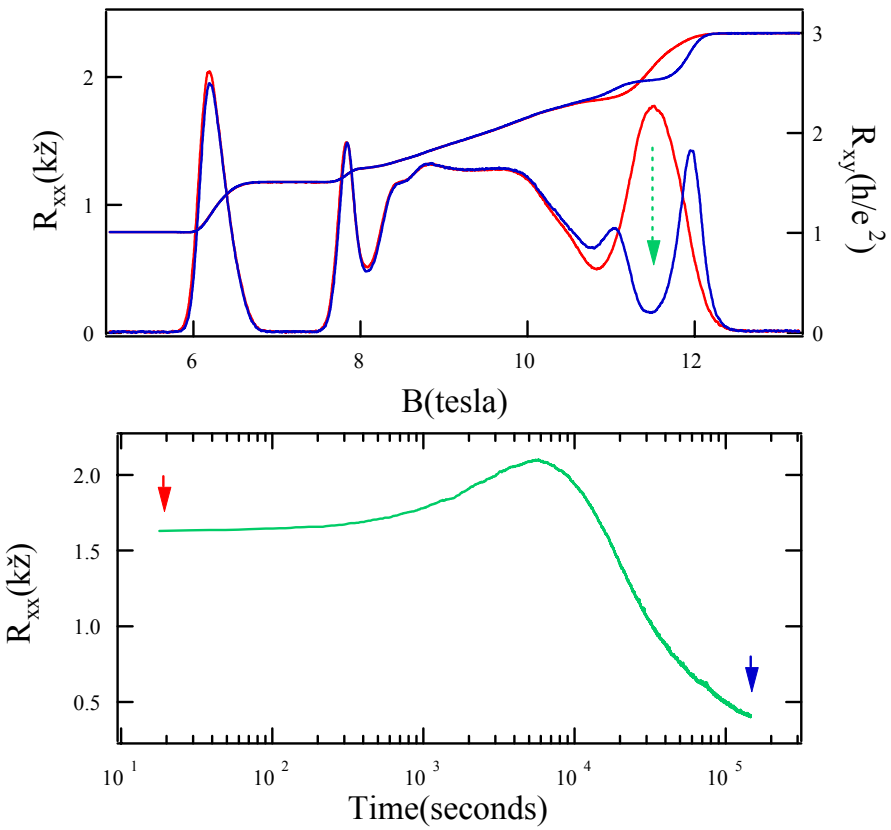

Upper figure illustrates the change in the magnetoresistance near ν = 2/5 filling before (red) and after (blue) the 2 day annealing. Lower trace shows the time dependence of magnetoresistance at ν = 2/5 filling in a semi-log plot.

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Education:

Two undergraduates (Judy Kim and Julian Edwards), and two graduate students (Pei-hsun Jiang and Nataliya Yufa), have contributed to this work. Judy Kim worked on the fabrication of novel superconductor-semiconductor heterostructure to study the motion of electrons in presence of Abrikosov flux lattice. Julian Edwards is working on a bachelor's thesis on single molecule junctions. Both of them plan to pursue graduate studies in physics in the upcoming year. Former undergraduate Michelle Chen is pursuing her PhD in Materials Science at the University of Pennsylvania.

Outreach:

With the help of physics department staff, the PI coordinated the summer REU program at the University of Chicago. Total of 26 students participated in a number of research and educational activities.

With the 2003 summer REU participants, mentors and physics department staff.